Utrecht University

ING

Designing a Virtual Environment in VR space using Memory Enhancement techniques

Introducing a VR approach to GDPR awareness training

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Global data protection regulations (GDPR)

- GDPR[1] was introduced on 25th May 2018.
- It was designed to harmonize the privacy regulations across Europe.
- It provides customers with the right to choose how their data would be used.
- It can lead to a fine of 4% of a company's turn over for a year, if any regulation is not followed.

Fig 1. GDPR simplified by ING

[1] Regulation (EU) 2016/679 of the European parliament and of the council of 27 April 2016; on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation). (2018, 25 May). [PDF file]. https://eur-lex.europa.eu/eli/reg/2016/679/oj

GDPR: How GDPR is Implemented at ING

- GDPR at ING[2] is implemented through multiple offices working together.
- Information is translated from higher to lower levels.

	First Line of Defense	Second Line of Defense
GDPP compliance Overall	**Bank DPE (Data Protection Executive)** Accountable for compliance with and implementation of the GDPP within ING globally.	**Bank DPO (Data Protection Officer)** Responsible for interpretation of the policy, advice and supervising compliance with the GDPP within ING global.
	Bank DPE Office On behalf of the Bank DPE performing the (coordinating) activities for compliance with and implementation of the GDPP.	**Bank DPO Office** On behalf of the Bank DPO performing the activities re. policy, advice and supervising compliance GDPP.
GDPP Compliance Business Unit	**BU DPE** Accountable for compliance with and implementation of the GDPP within the business unit.	**BU DPO** Responsible for providing advice to BU DPE and supervising compliance with the GDPP within the business unit.
	BU DPE Office Performs operational activities relating to the compliance of GDPP commissioned by the BU DPE and the CDO.	
Personal Data Management	**CDO (Chief Data Officer)** Responsible for setting up the data mgt. strategy and data governance and accountable coordinating with the Data Owners within the BU.	
	Data Owner* Responsible for managing data during its lifecycle, including Data Access, Data Lineage and archiving/deletion.	

*) The data owner can delegate specific tasks to the data steward. In most cases, the data owner is also the process owner.
**) Personal data management is part of data management.

Fig 2. GDPR workflow by ING[2]

[2] Communication office ING (2018,February). Getting ready for GDPR. Retrieved from https://intranet.ing.net/sites/StaffSupport-global/OPS/Documents/GDPR%20Communication%20Pack.pdf

GDPR: Training Exercises at ING

- The trainings provides to the ING for compliance training comprise of e-learnings[3] or privacy statements.
- These e-learnings are mandatory as it provides the most information required for the employees to conduct their jobs.
- GDPR exercises haven't been introduced yet.

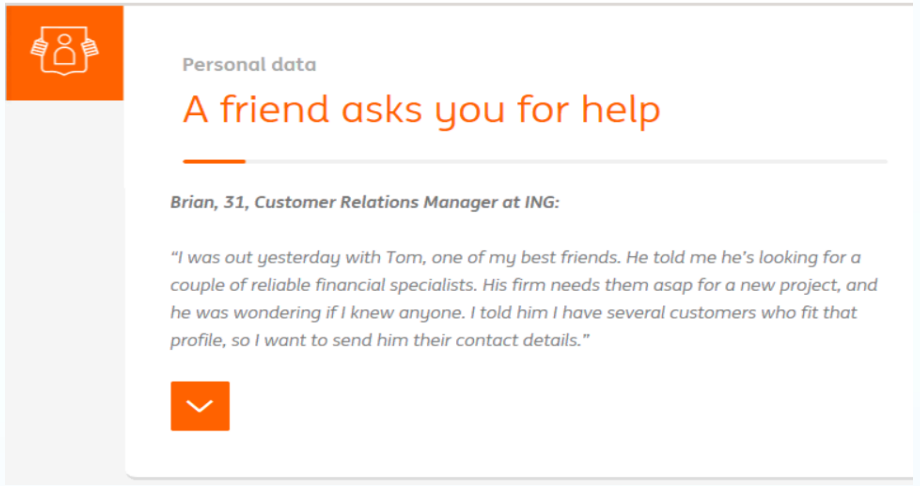


Fig 3. Question Example[3]

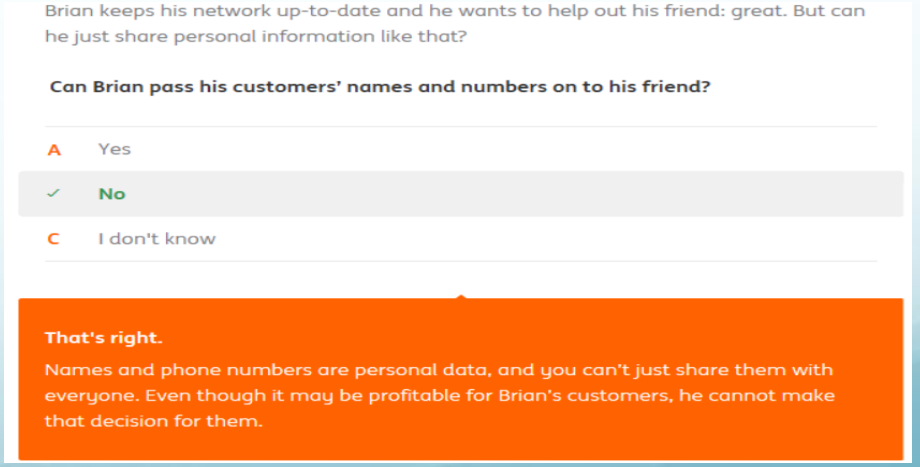


Fig 4. Question Example Contd.[3]

[3] ING Learning Centre. (2018). ING Training. Retrieved from https: //www.inglearn.com/ingtraining2/servlet/ekp?PX=N&TEACHREVIEW=N&CID=EKP000006144&TX=FORMAT1&LANGUAGE_TAG=*ALL*&DECORATEPAGE=N

Related Work

- Memory Process
- The Memory Palace Technique (Method of Loci)
- Memory Palace in VR
- Search and Interaction Aid recall

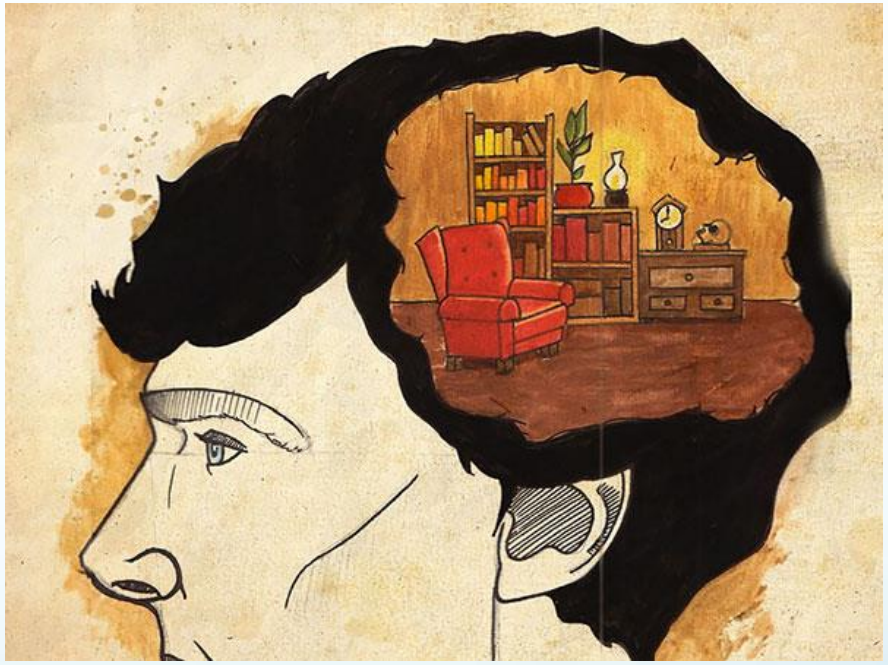


Fig 5. Example Memory Palace

Related Work: Memory Process

- Bloom's Taxonomy[4]
- Baddeley Model[5]

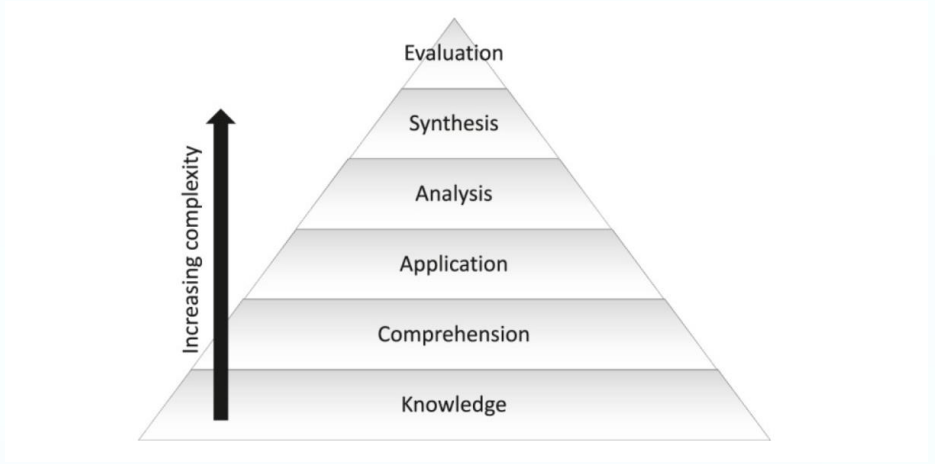


Fig 6. Bloom's Taxonomy. Reprinted[4]

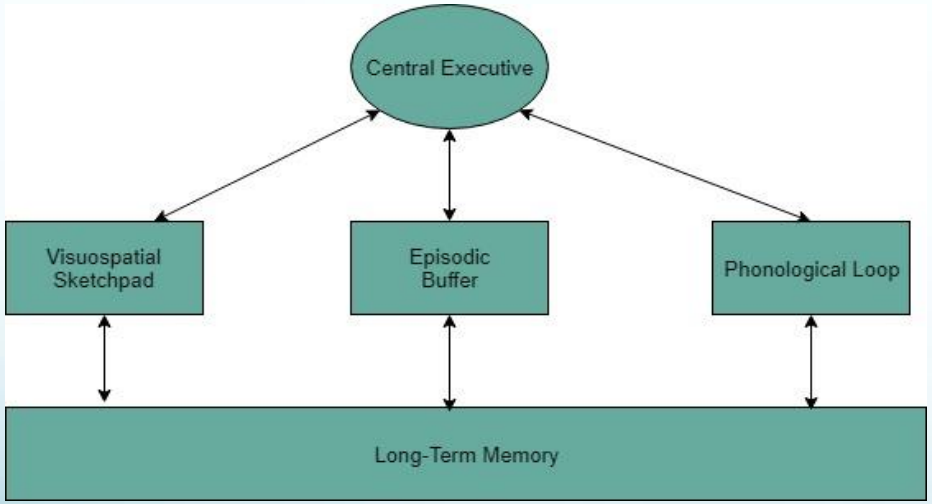


Fig 7. Baddeley's Model[5]

[4] Adams, N.E. (2015). Bloom's taxonomy of cognitive learning objectives. Journal of the Medical Library Association, 103(3), 152-153. https://doi.org/10.3163/1536-5050.103.3.010.
[5] Matlin, M.W. (Ed.) (2014). Cognitive Psychology (5th Ed), International Student Version. New Jersey: John Wiley

Related Work: Memory Process

- Baddeley Model[5]
  - Visuospatial Sketchpad
  - Phonological Loop
  - Episodic Buffer
  - Central Executive
  - Long Term Memory
    - Encoding
    - Retrieval
    - Autobiographical Memory
- Spatial Memory: *"the memory system that encodes, stores, recognizes, embodies, and recalls spatial information about the environment"*[6,7]

[6] Krokos,E., Plaisant, C. & Varshney,A. (2018). Virtual memory palaces: immersion aids recall. Virtual Reality. https://doi.org/10.1007/s10055-018-0346-3.
[7] Madl, T., Chen, K., Montaldi, D., Trappl, R. (2015). Computational cognitive models of spatial memory in navigation space: a review. Neural Networks, 65, 18-43. https://doi.org/10.1016/j.neunet.2015.01.002.

Related Work: The Memory palace technique

- Existed for as long as 400 B.C and introduced by an unknown Greek author[8].
- Involves in creating a virtual palace in the mind to store relevant information at specific locations that can be revisited.
- Requires multiple processing of information leading to better retention[5,9].
- Ad Herennium[8,10] mentions guidelines for an efficient memory palace:
  - The space should be solitary and not very crowded.
  - Distance between loci should be at-least 10 meters.
  - Having a unique sign every fifth loci
  - Avoid repetitive environments.
  - The loci in a neither too spacious nor too narrow.
  - The loci is not lighted too dark or too bright.

[8] Yates, F.(2000). The Art of Memory. Pimlico, London
[9] Baddeley, A., Eysenck, M.W., & Anderson, M.C.(2009). Memory. New York: Psychology Press
[10] Fassbender, E. & Heiden W.(2006). The Virtual Memory Palace. Journal of Computational Information Systems,2, 457-464.

Related Work: Memory Palace IN VR (VMP)

- VMP showed effectiveness in increasing retention of information for words[6,10].
- Employee training exercises are also being implemented using virtual environments[11].
- Wouters et. al.[12] mentions the use of instructional techniques increase learning and motivation while developing serious games when compared to serious games with no instructional techniques.
- Some instructional techniques needed to be applied to the VE in the study to ensure replay ability. Such as; content integration, interactivity, level of realism, personalization and reflection.

[11] Orvis, K.A., Horn, D.B., Belanich, J. (2009). An examination of the role individual differences play in videogame-based training. Military Psychology MIL PSYCHO, 21, 461-481. https://doi.org/10.1080/08995600903206412.
[12] Wouters, P., Oostendorp, H. (Eds.) (2017). Overview of Instructional Techniques to Facilitate Learning and Motivation of Serious Games. https://doi.org/10.1007/978-3-319-39298-1

Related Work: Search and interaction aid recall

- VMP used in Head mounted displays are more effective than desktop variants[6].
  - Comparing the presence of a target in an environment[13]
  - Traversing a virtual airport[14]
- VMPs in virtual environments showed connection between navigation, interaction and recall[15].

[13] Pausch, R., Proffitt, D., Williams, G. (1997). Quantifying immersion in virtual reality. Quantifying Immersion in Virtual Reality. Proceedings of SIGGRAPH'97, 13-18. https://doi.org/10.1145/258734.258744
[14] Perrault, S.T., Lecolinet, E., Bourse, Y.P., Zhao, S. & Guiard, Y. (2015). Physical loci: leveraging spatial, object and semantic memory for command selection. CHI'15 Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems, 299-308. https://doi.org/10.1145/2702123.2702126
[15] Brooks, B.M., Elizabeth A.A., Rose, F.D., Clifford, B.R. & Leadbetter, A. (1999). The specificity of memory enhancement during interaction with a virtual environment. Memory, 7(1), 65-78. https://doi.org/10.1080/741943713

Research Question

Can a virtual environment (VE) where the design is inspired by the memory palace technique and the memory process be used as a learning tool? (teaching about GDPR compliances specifically data privacy compliances)

Experiment

- Environment Design
- Experiment Design

Fig 8. Student Participant

Experiment: Environment Design

- Environment built using pre-built assets (Lowpoly Tropical Island created by Brainbox) in Unreal engine.
- The information (guidelines) to be taught was placed at different checkpoints which were numbered 1-10.
- The layout of the information and the design was inspired by *Ad Herennium*[8,10] guidelines.
- Caves were added to provide an extra layer to the environment[7,8,9].

Fig 9. Environment Overview

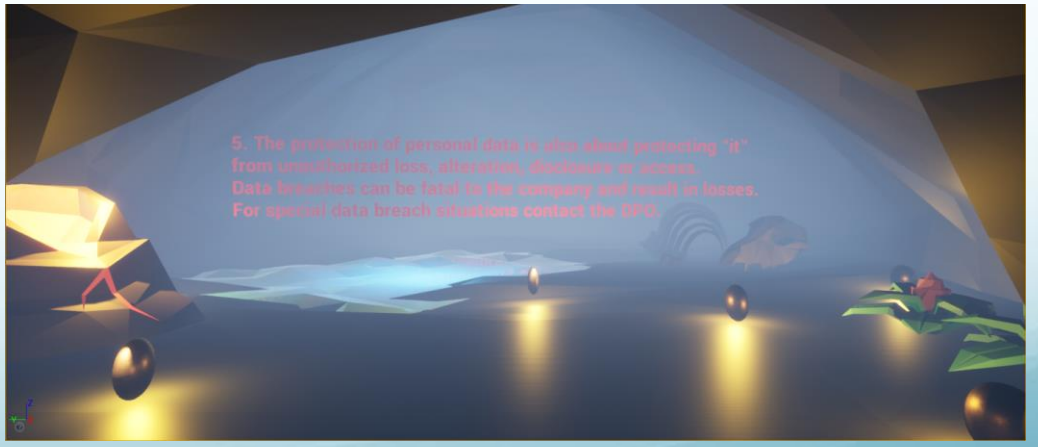


Fig 10. Environment Cave Showcase

Experiment: Environment Design

- The environment design was landmark driven to support navigation[16].
- The 3-D sound[17] used in the environment is that of a beach consisting of wind flow and bird sounds to provide immersion.
- Navigational techniques were added to help navigating an unknown environment. Landmark technique[16] and Trailblazing technique[16].

Fig 11 & 12. Coins and Arrows used as part of navigation

[16] Darken, R.P. & Sibert, J.L. (1993). A toolset for navigation in virtual environments. 6th annual ACM symposium on User interface software and technology,157-165. https://doi.org/10.1145/168642.168658
[17] Durand, B. (2001). 3-D Sound For Virtual Reality and Multimedia. Moffett Field, California: National Aeronautics and Space Administration.

Experiment Design

- Participants
- Setup and Procedure
- Information used in the environment (Guidelines)
- Test Sessions

Fig 13. Student Participant performing the experiment

Experiment Design: Information used in the environment (Guidelines)

- Personal data means: any information relating to an identified or identifiable natural individual. Sharing personal data of a customer can only be done in case of a legitimate business reason.
- ING shall only collect, use or otherwise Process Personal Data, if the Processing falls within the scope of one (or more) of the legitimate Business Purpose : Some of ING's legitimate business purposes are: Performing agreements, Safety and security.
- Sometimes it is possible to use the personal data for secondary business purposes. For example: For statistical research, For internal audits, For legal and business consulting.
- Irreversibly and effectively anonymized data is not 'personal data' and the data protection principles do not have to be complied with in respect of such data. Pseudonymized (encrypted anonymized) data remains personal data.
- The protection of personal data is also about protecting it from unauthorized loss, alteration, disclosure or access. Data breaches can be fatal to the company and result in losses. For special data breach situations contact the DPO.
- Every Individual has the right to request an overview of his Personal Data Processed by or on behalf of ING.
- ING shall Process Sensitive Data only to the extent necessary to serve the applicable legitimate purposes. Some examples: Political opinions, Criminal records, Sexual orientation, Social security number, Or any other data defined as sensitive by local.
- Whenever you want to process personal data, think about what it is for, and if you need to take additional measures beforehand.
- All personal data that ING collects, stores and processes must be correct and up-to-date at any time.
- ING shall only retain personal data for the period required to serve the applicable purposes, or for legal reasons.

Experiment Design: Test Sessions

- Instructions on using the VR, the controls and the experiment.
- Participants used the environment for 20 minutes.
- Participants solved a Sudoku puzzle for 5 minutes
- Participants answered an environment recall test followed by a questionnaire based on the guidelines used in the virtual environment
- Lastly, a small discussion was conducted with the participants regarding their preference on using the environment on a regular basis.

Vid. ING participant test session

Experiment Design: Test Sessions

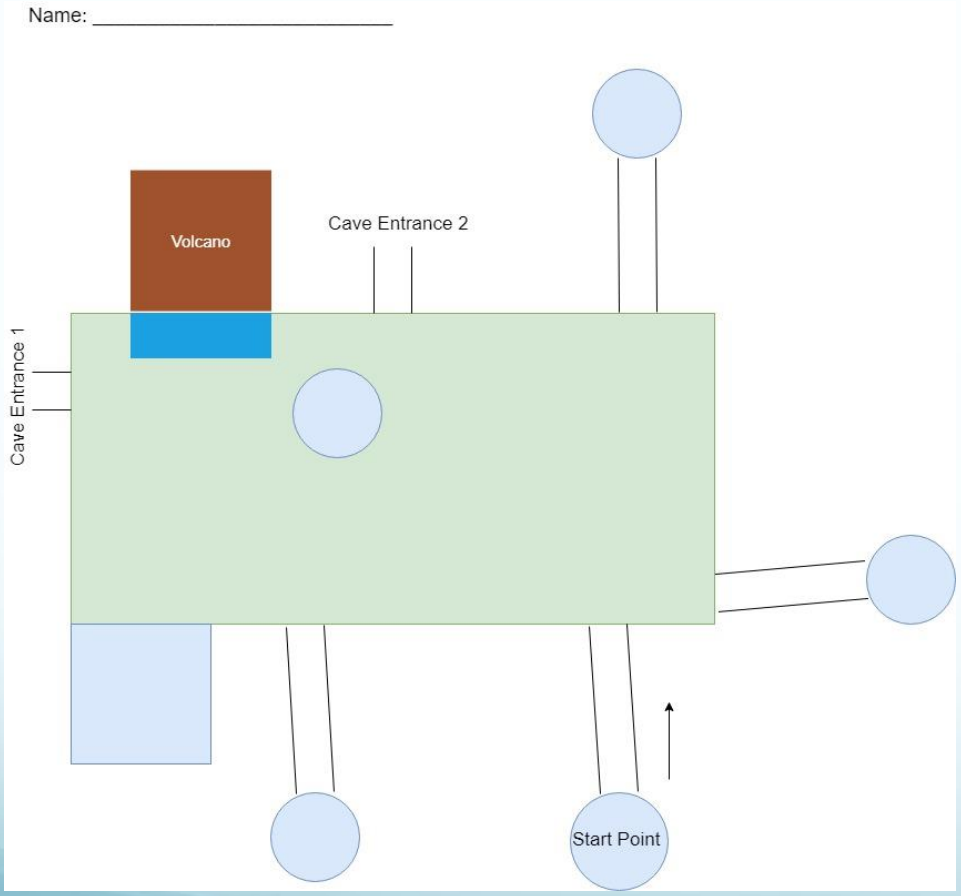


Fig 14. Environment Recall Test - Island Top area

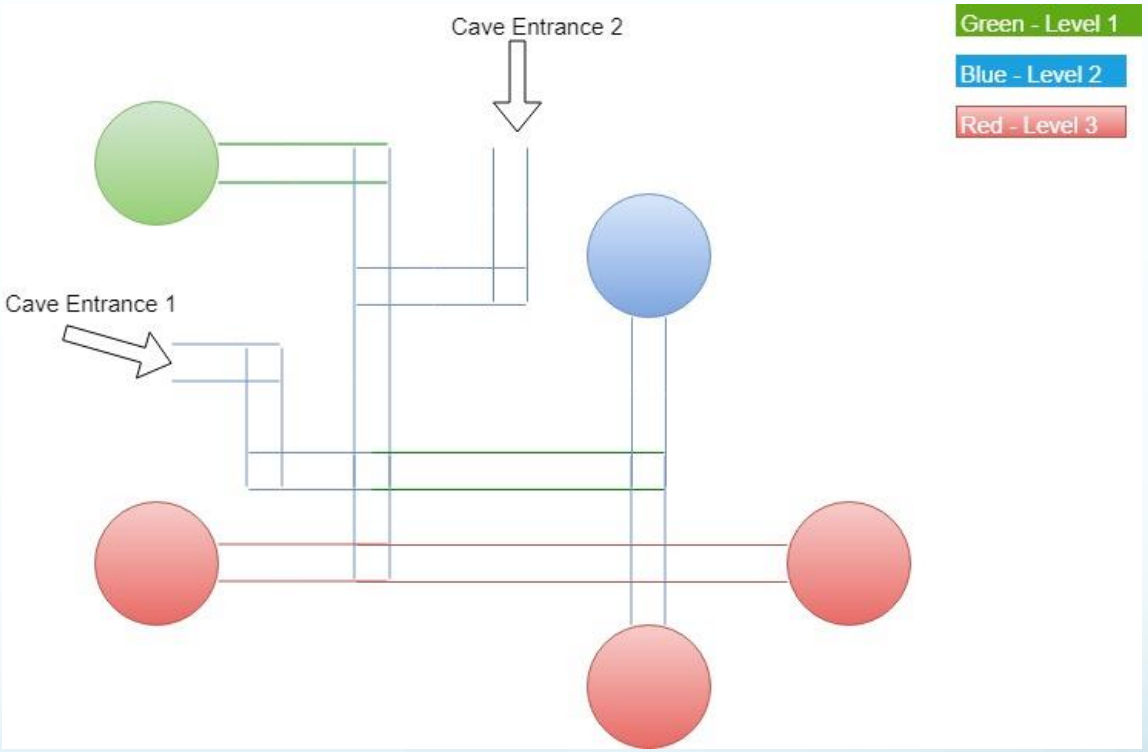
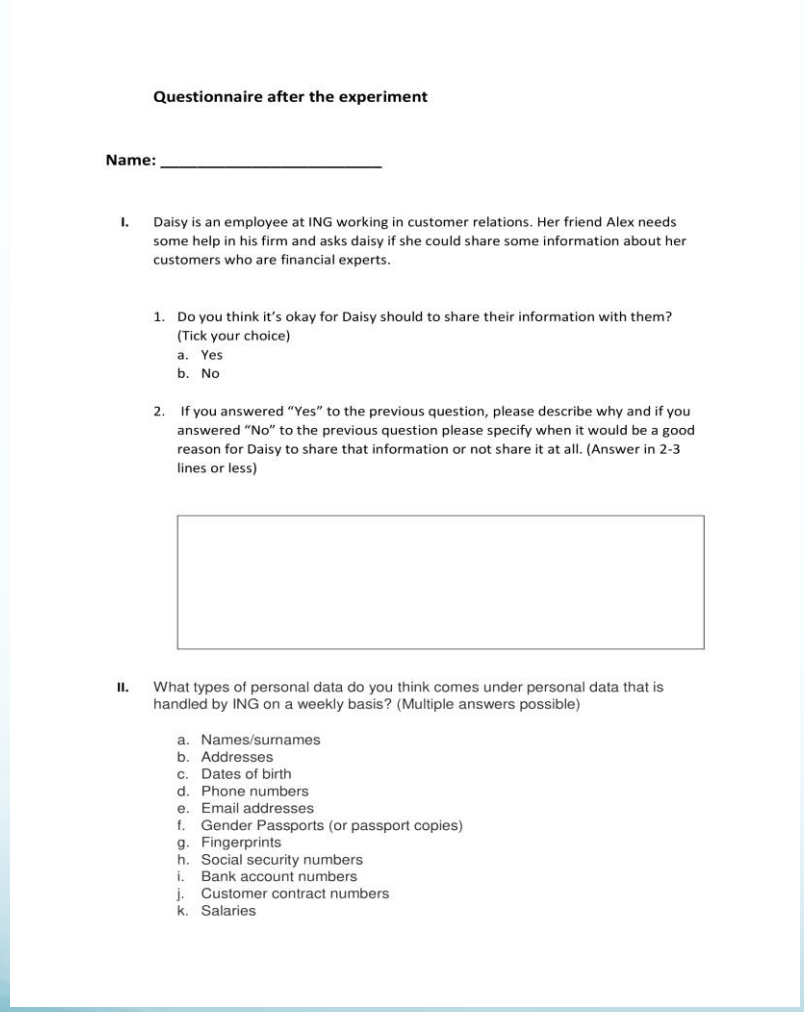


Fig 15. Environment Recall Test – Cave System

Experiment Design: Test Sessions



Questionnaire after the experiment

Name: _____

I. Daisy is an employee at ING working in customer relations. Her friend Alex needs some help in his firm and asks daisy if she could share some information about her customers who are financial experts.

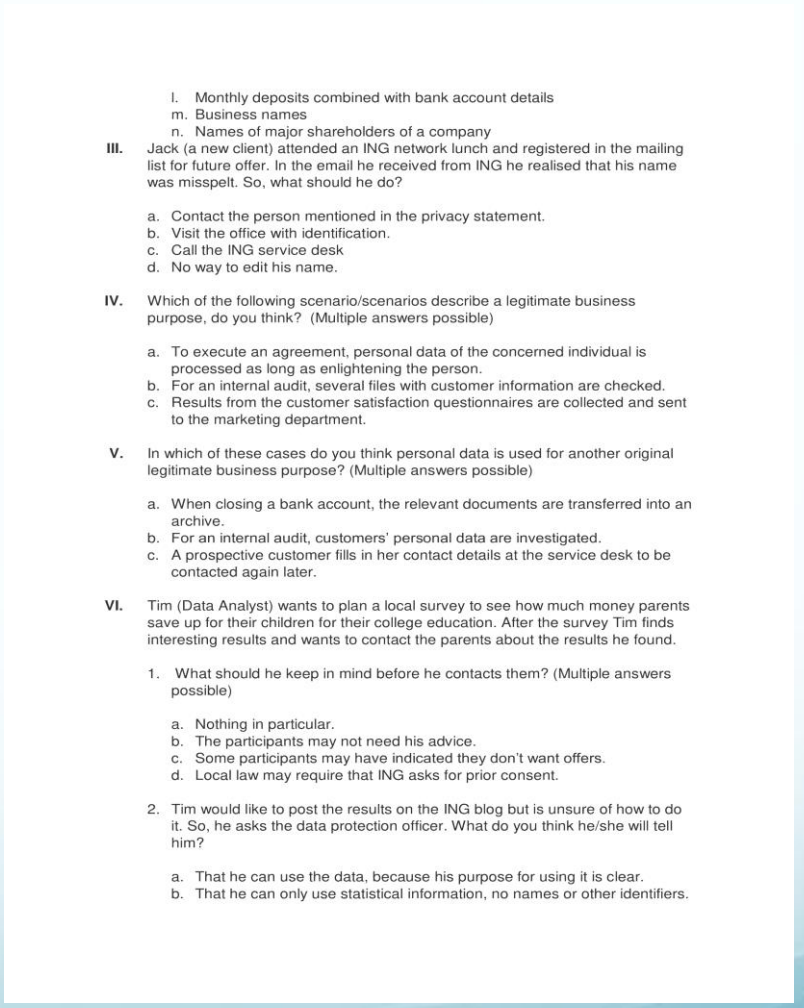
1. Do you think it's okay for Daisy should to share their information with them? (Tick your choice)
   a. Yes
   b. No

2. If you answered "Yes" to the previous question, please describe why and if you answered "No" to the previous question please specify when it would be a good reason for Daisy to share that information or not share it at all. (Answer in 2-3 lines or less)

II. What types of personal data do you think comes under personal data that is handled by ING on a weekly basis? (Multiple answers possible)

a. Names/surnames
b. Addresses
c. Dates of birth
d. Phone numbers
e. Email addresses
f. Gender Passports (or passport copies)
g. Fingerprints
h. Social security numbers
i. Bank account numbers
j. Customer contract numbers
k. Salaries

Fig 16. Final Questionnaire Example 1



l. Monthly deposits combined with bank account details
m. Business names
n. Names of major shareholders of a company

III. Jack (a new client) attended an ING network lunch and registered in the mailing list for future offer. In the email he received from ING he realised that his name was misspelt. So, what should he do?

a. Contact the person mentioned in the privacy statement.
b. Visit the office with identification.
c. Call the ING service desk
d. No way to edit his name.

IV. Which of the following scenario/scenarios describe a legitimate business purpose, do you think? (Multiple answers possible)

a. To execute an agreement, personal data of the concerned individual is processed as long as enlightening the person.
b. For an internal audit, several files with customer information are checked.
c. Results from the customer satisfaction questionnaires are collected and sent to the marketing department.

V. In which of these cases do you think personal data is used for another original legitimate business purpose? (Multiple answers possible)

a. When closing a bank account, the relevant documents are transferred into an archive.
b. For an internal audit, customers' personal data are investigated.
c. A prospective customer fills in her contact details at the service desk to be contacted again later.

VI. Tim (Data Analyst) wants to plan a local survey to see how much money parents save up for their children for their college education. After the survey Tim finds interesting results and wants to contact the parents about the results he found.

1. What should he keep in mind before he contacts them? (Multiple answers possible)

   a. Nothing in particular.
   b. The participants may not need his advice.
   c. Some participants may have indicated they don't want offers.
   d. Local law may require that ING asks for prior consent.

2. Tim would like to post the results on the ING blog but is unsure of how to do it. So, he asks the data protection officer. What do you think he/she will tell him?

   a. That he can use the data, because his purpose for using it is clear.
   b. That he can only use statistical information, no names or other identifiers.

Fig 17. Final Questionnaire Example 2

Results

Fig 18. Environment Recall Scores

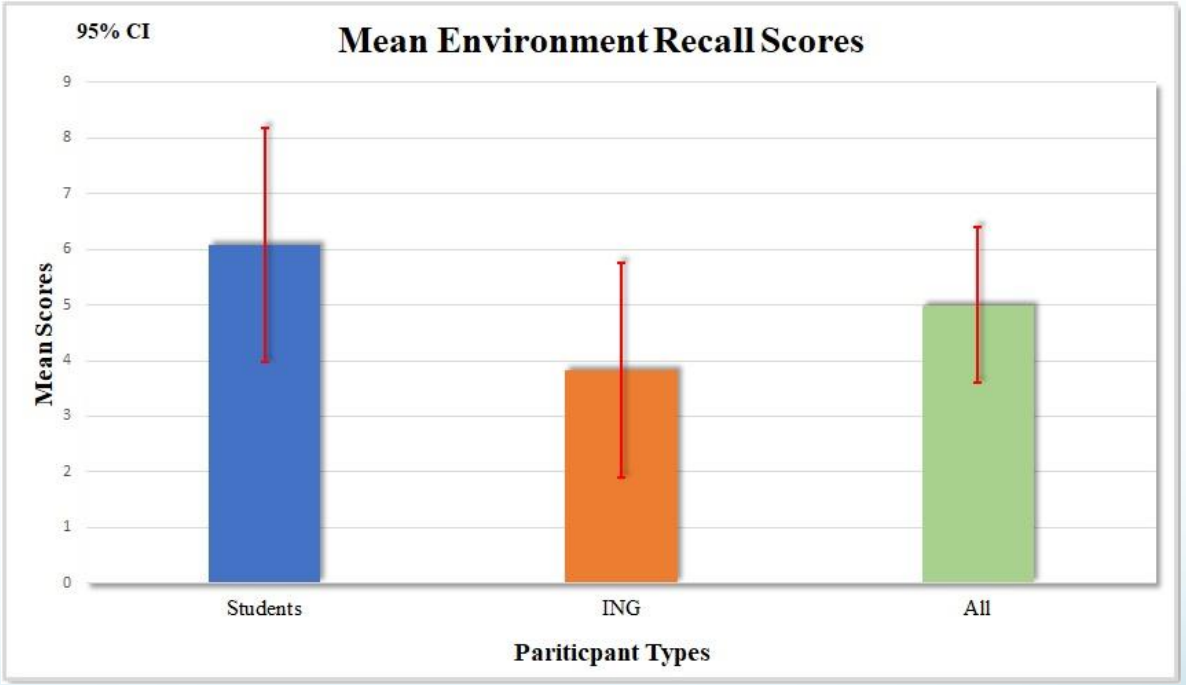


Fig 19. Environment Recall Scores Mean

Results

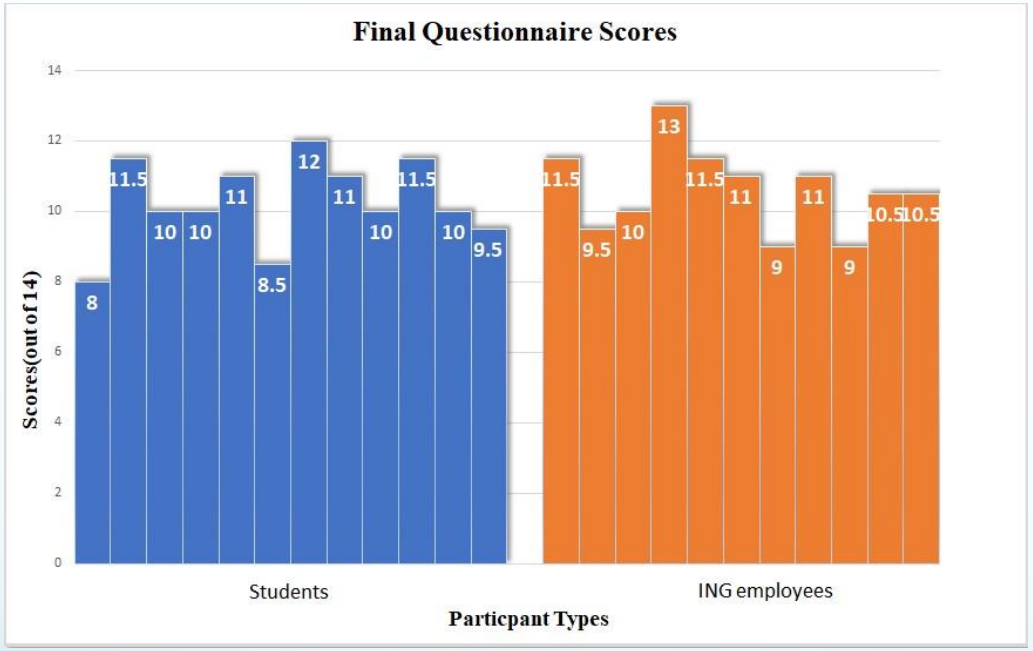


Fig 20. Final Questionnaire Scores

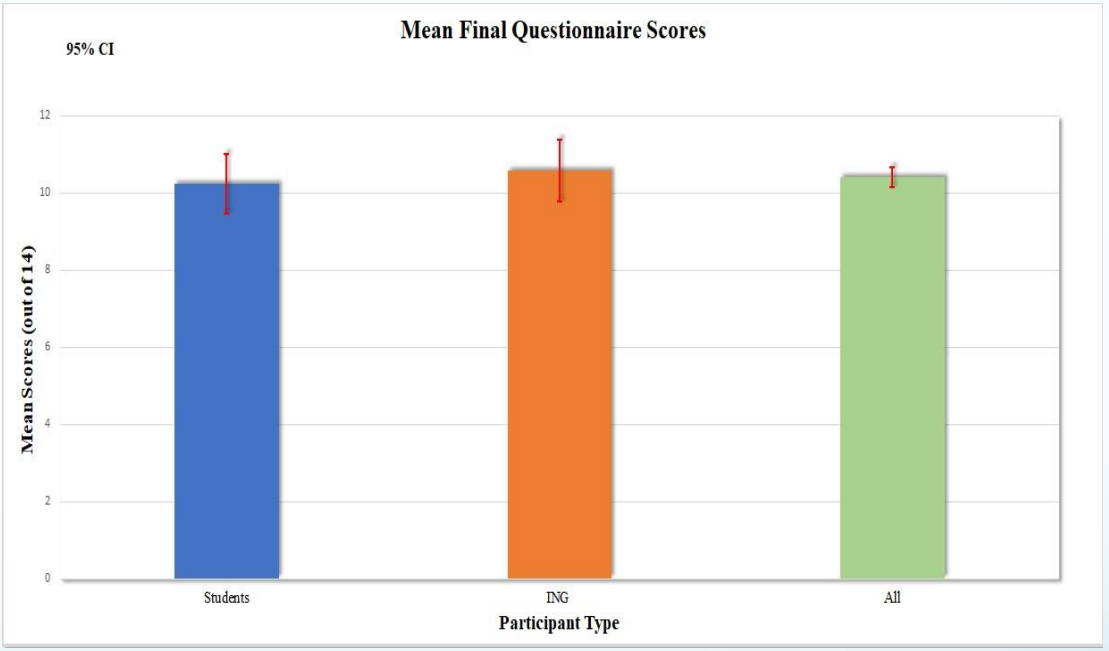


Fig 21. Final questionnaire scores mean

Results

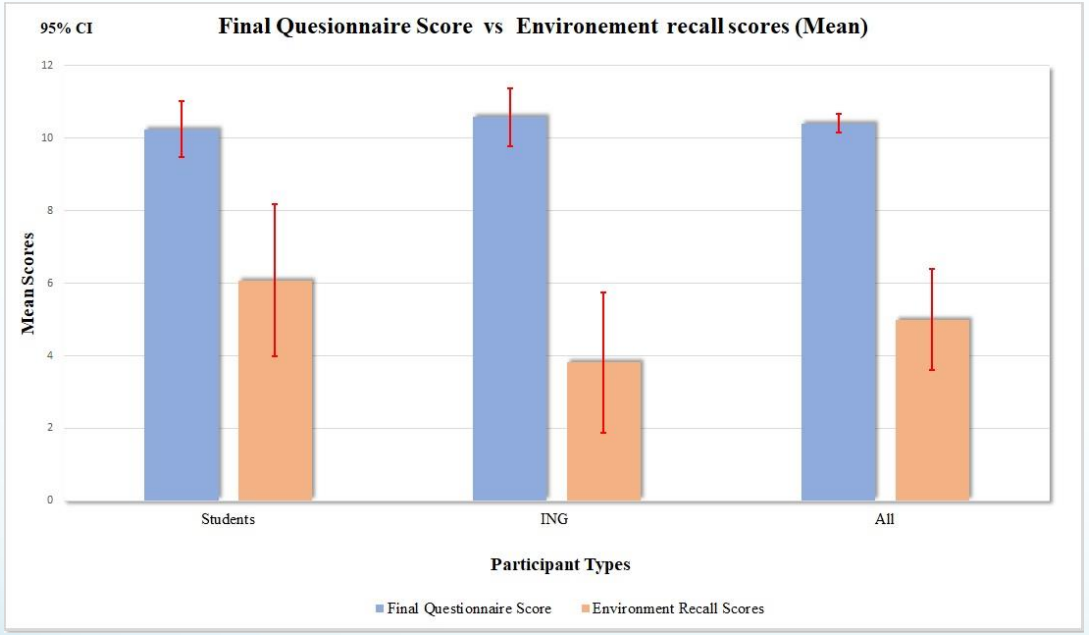


Fig 22. Final Questionnaire Scores vs Environment Recall Scores

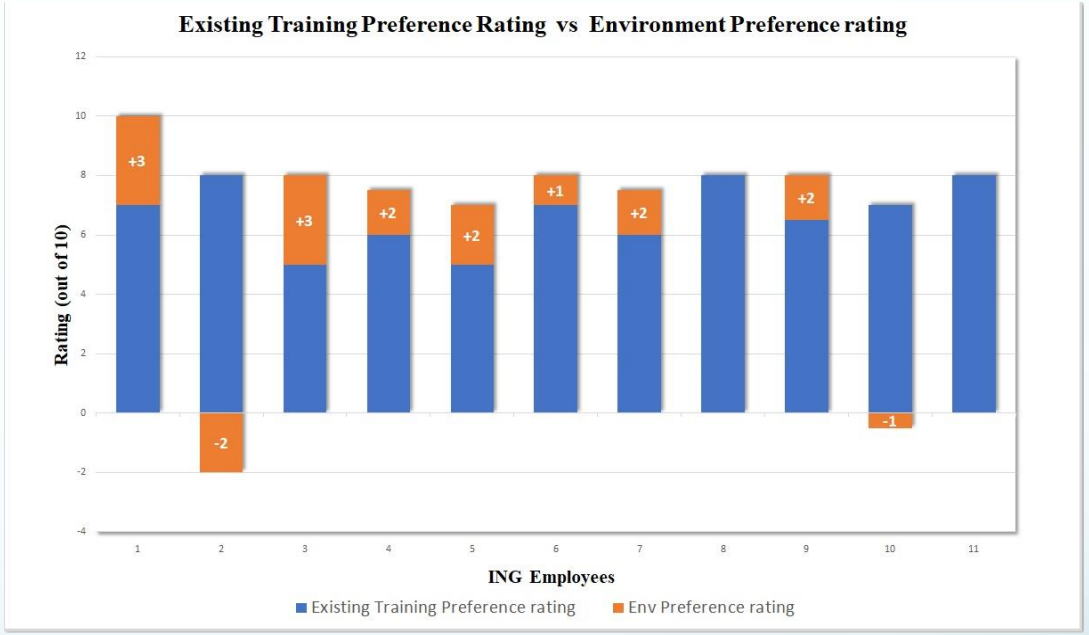


Fig 23. ING Employees Environment Preference Rating

Results

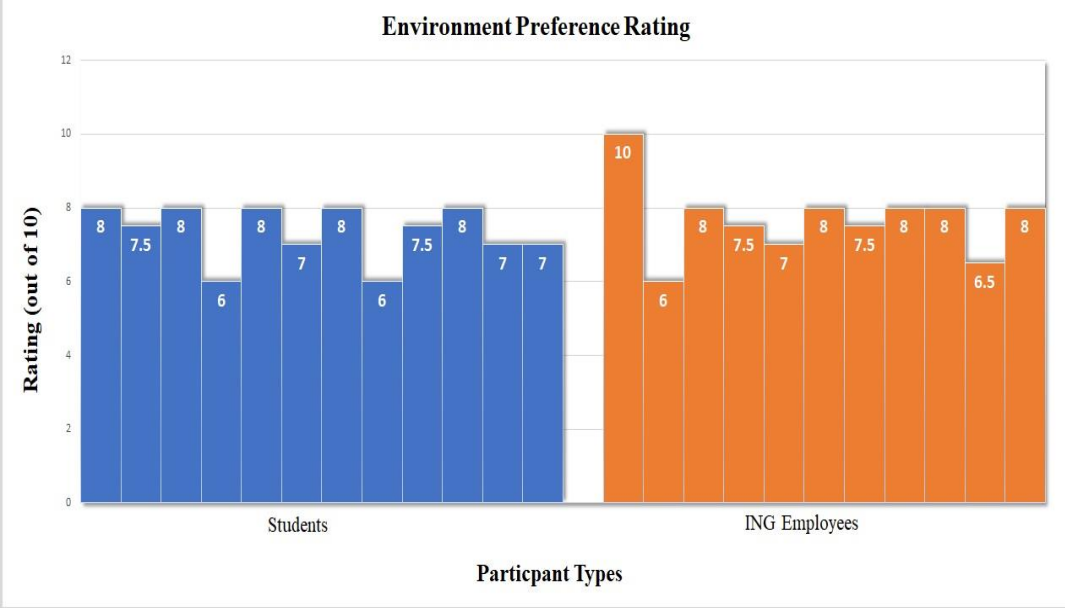


Fig 24. Environment Preference Rating for all participants

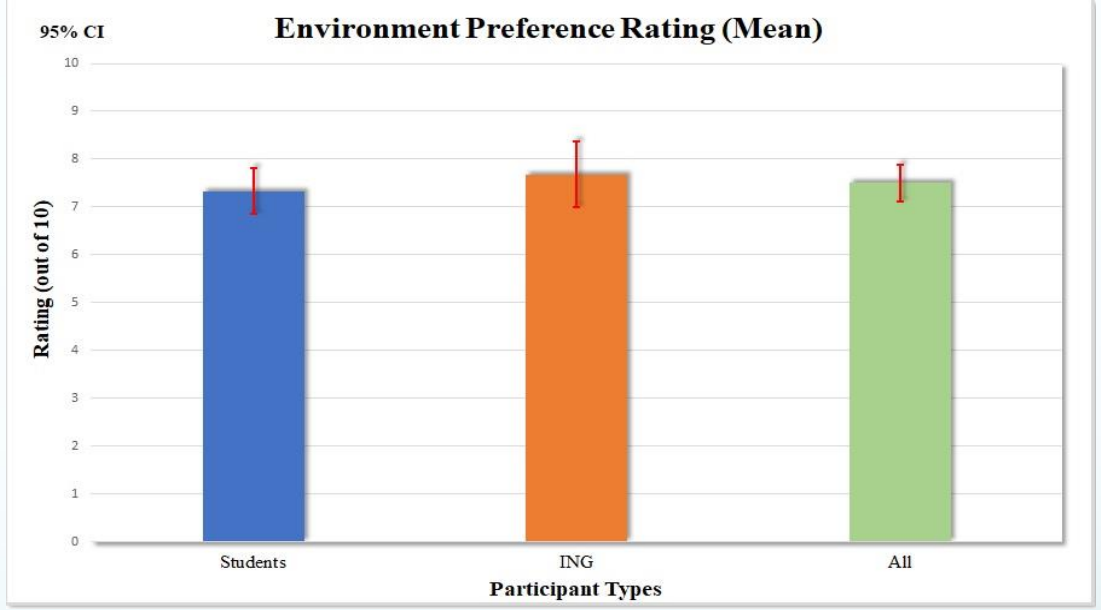


Fig 25. Environment Preference Rating Mean

Results

Participant Discussion

- The environment can be quite immersive.
- Better than using a PowerPoint.
- 20 minutes not long enough.
- Can be difficult to use daily due to multiple elements.
- The environment was fun to use.
- Colours can be distracting.
- Information and the environment weren't linked

Discussion

- Higher age groups performed lower in the environment recall test.
  - Visuospatial and recall performance reduced with age[18,19].
  - Less number of participants.
  - Lower age groups have better affinity towards VR.
  - Prior experience with VR.
  - Less amount of time spent in the environment.
- Participants showed co-relation between placement of checkpoints.
- The VE showed signs of learning with lower age groups and is inconclusive for higher age groups.
- Both groups of participants preferred to use the VE as a replacement to their existing learning methods

[18] Jenkins, L., Myerson, J., Joerding, J.A. & Hale, S. (2000). Converging evidence that visuospatial cognition is more age-sensitive than verbal cognition. Psychology and aging, 15, 157-75. https://doi.org/10.1037/0882-7974.15.1.157.
[19] Craik, F. & Mcdowd, J. (1987). Age Differences in Recall and Recognition. Journal of Experimental Psychology: Learning, Memory, and Cognition, 13, 474-479. https://doi.org/10.1037/0278-7393.13.3.474.

Conclusion

- Exploratory research into applying memory enhancement techniques in a VE.
- Showcased even 20 mins of session can induce learning (in lower age groups).
- The results were not 100% conclusive and did not answer the research question fully.
- The participants preferred to use the VE as a daily learning tool.

Conclusion: Key challenges of the study

- Scope of the study was reduced.
- The experiment design lacked some useful comparisons.
- Designing the VE took longer than expected leading to slower and imprecise experiment design.
- The effect of VE on the memory process.
- Finding relevant literature.
- The results from a visuospatial test – Rey Osterrieth Complex Figure test[20,21] were discarded.

[20] Canham, R., Smith, S. Tyrrell, A. (2000). Automated Scoring of a Neuropsychological Test: The Rey Osterrieth Complex Figure. Proceedings of the EUROMICRO, 2, 2406-
2413. https://doi.org/10.1109/EURMIC.2000.874519.
[21] A. Rey and P. Osterrieth. (1993). Translations of excerpts from Rey's âAŸPsychological Examination of Traumatic Encephalopathy' and Osterrieth's âAŸThe Complex Figure Test'. The Clinical Neuropsychologist, 7, 2-21.

Future work

- Implement the VE as a VMP.
- Testing with multiple sessions of the VE (for higher age groups).
- Make the VE more personalised with freedom to change information in the environment.
- Do interactive questionnaires inside the VE.
- Use different types of environments.

Thank you